The stock-flow-service nexus of Bogotá's bus rapid transit

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The International Society for Industrial Ecology (ISIE) Americas 2020
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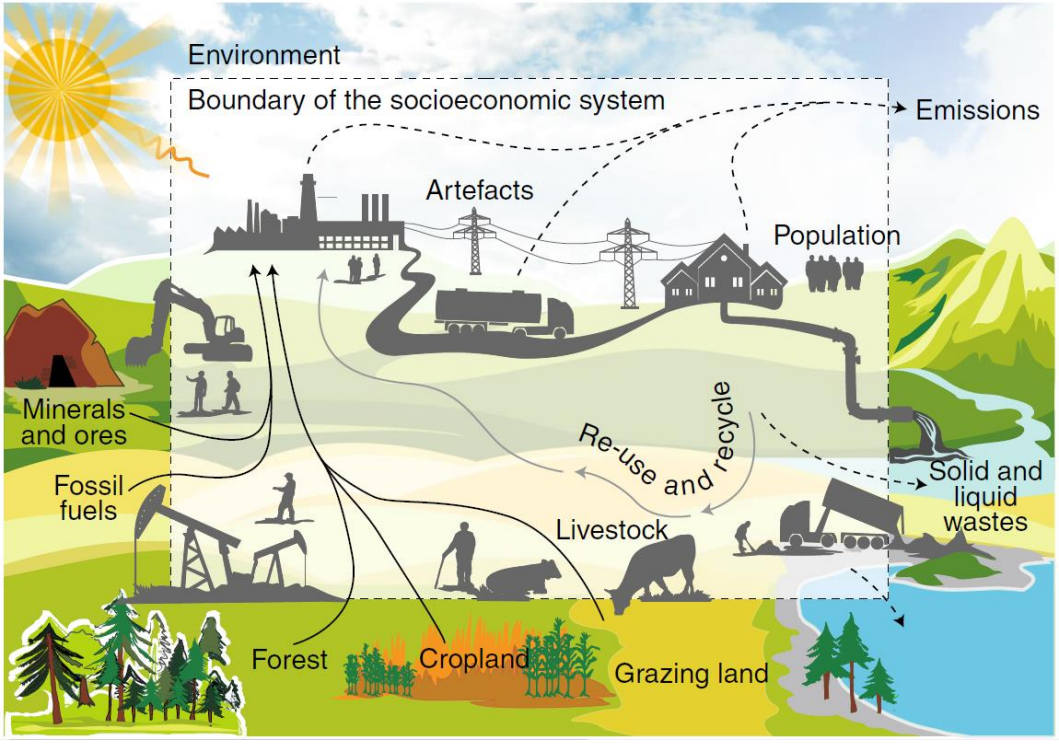
Introduction

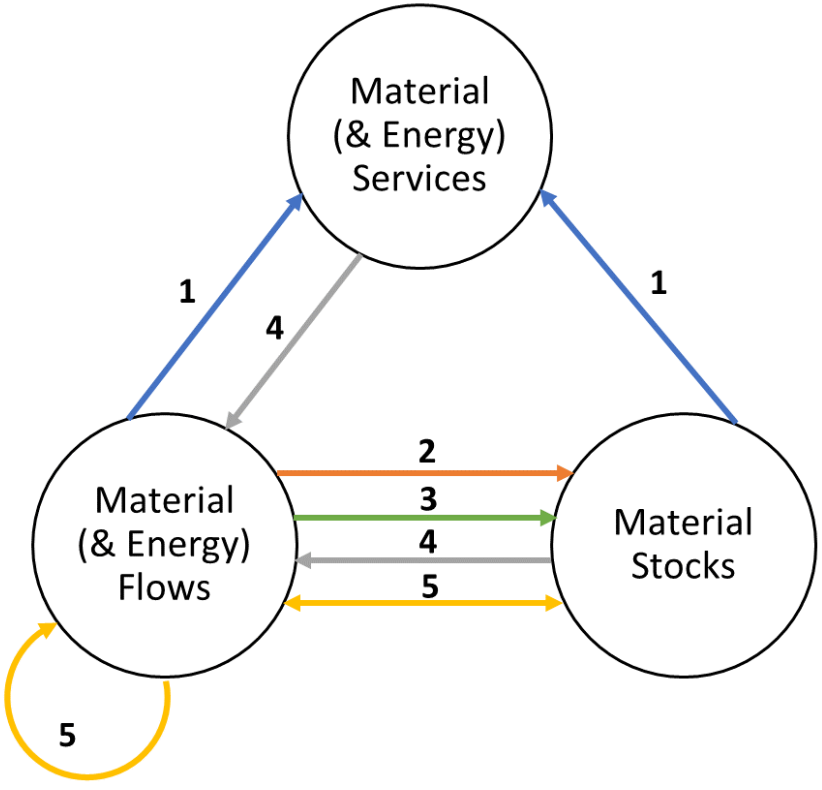
- Socioeconomic development relies on natural resources, including in-use stocks in the form of products and infrastructure.
- Services are provided by specific combinations of material stocks and flows.



Source: Haberl et al (2019)

Stock-flow-service nexus

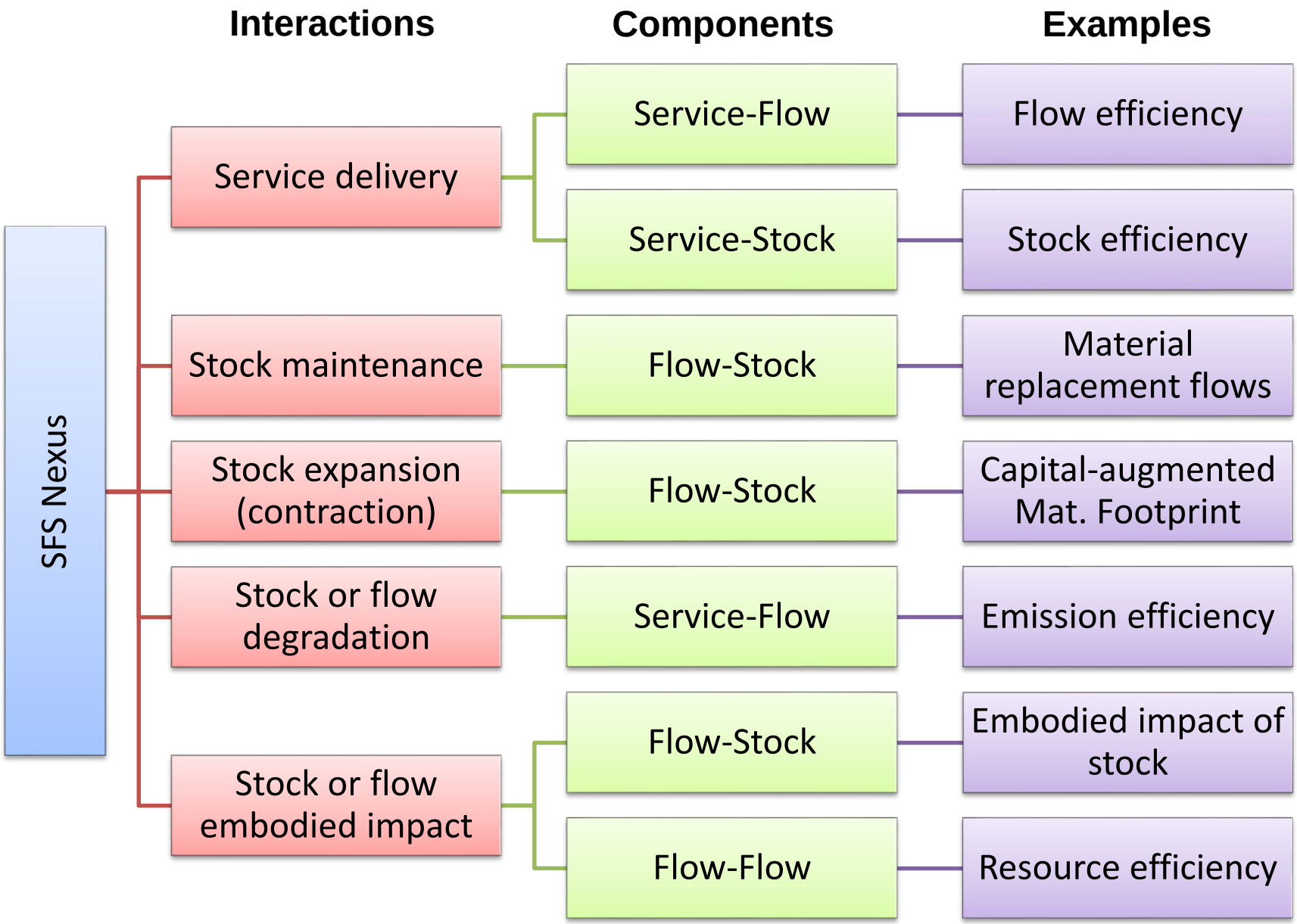
- It captures the interconnections between material and energy flows, material stocks and the services that resources directly provide.
- Opens up a systems-based understanding of resource use.
- The interactions are not necessarily linear or commensurable, and can be expressed as efficiencies or rates.



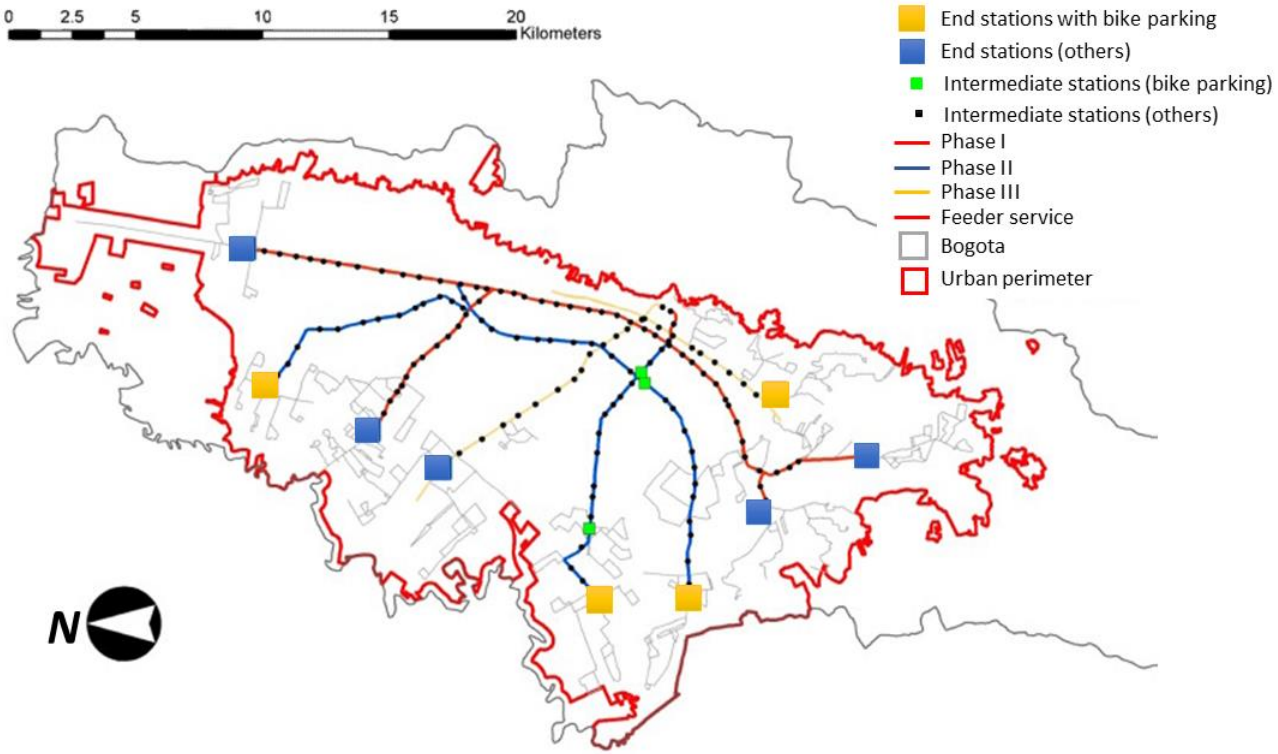
N	Interaction
1	Service delivery
2	Stock maintenance
3	Stock expansion
4	Stock or flow degradation
5	Stock or flow embodied impact

Source: Adapted from Carmona et al (2020)

Stock-Flow-Service Indicators



Bogota's BRT


0
2.5
5
10
15
20
Kilometers
End stations with bike parking
End stations (others)
Intermediate stations (bike parking)
Intermediate stations (others)
Phase I
Phase II
Phase III
Feeder service
Bogota
Urban perimeter
N

Method

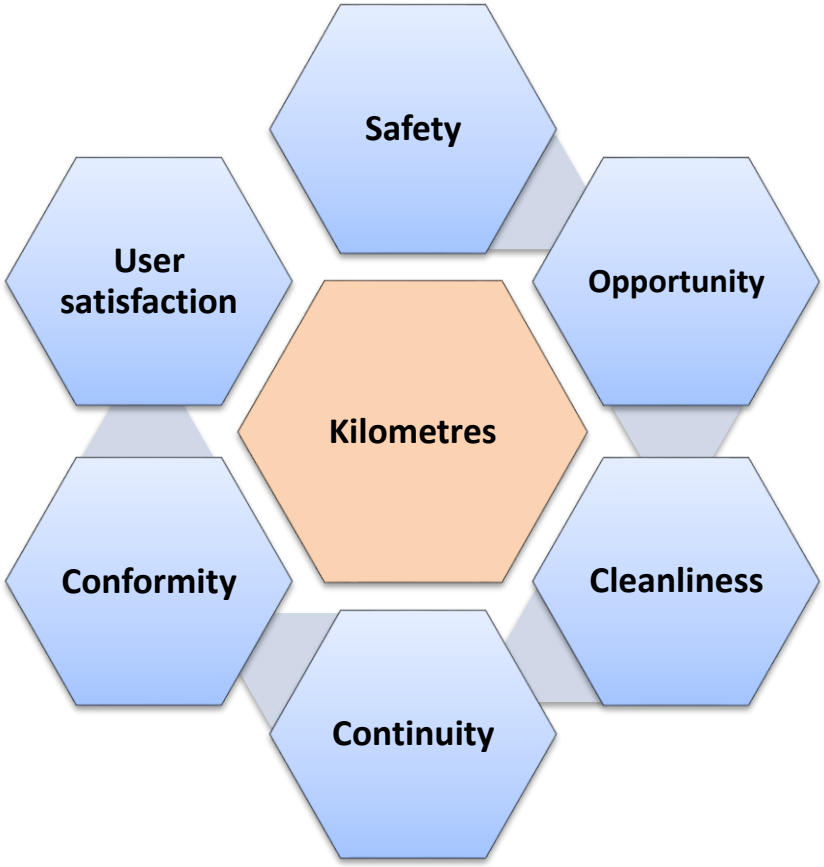
Scope: Operations prior to stock optimisation strategy (2001-2007) and operations following stock optimisation strategy (2008-2011)

Quantifying Flows: Fuel consumption, vehicle spare parts and waste flows

Quantifying Stocks: 125 bi-articulates buses Euro II

Quantifying the Transport Service: kilometres

Service parameters

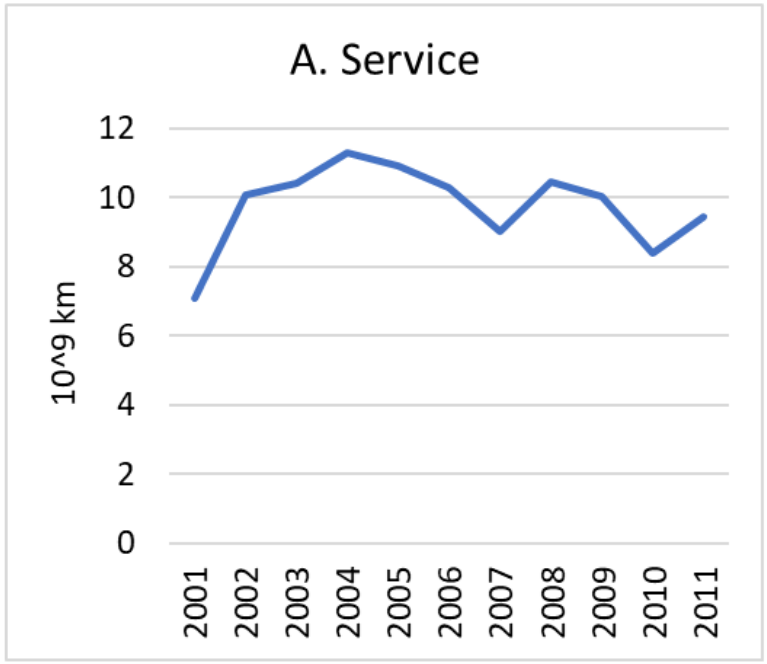


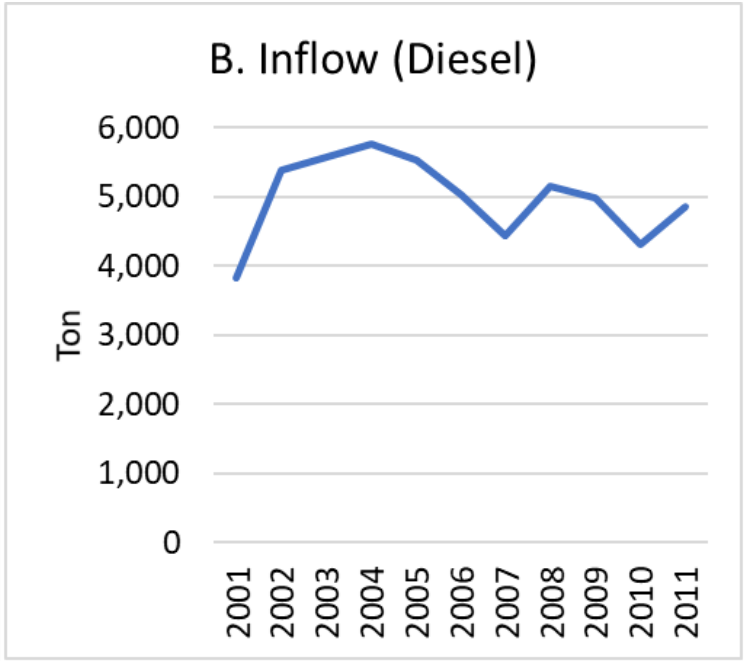
Stock-Flow-Service Indicators

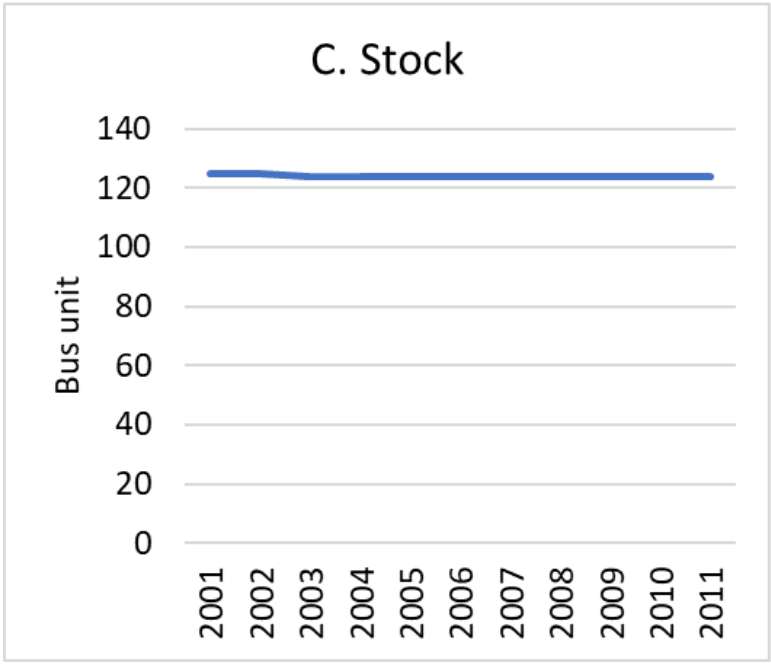
Indicator	Description	General Equations
Stock efficiency	The amount of stock required to provide a unit of service	$\frac{Serv.}{M_{Stock}}$
Flow efficiency	The amount of inflow that is directly consumed to provide a unit of service	$\frac{Serv.}{M_{Inflow}}$
Stock degradation efficiency	The amount of stock that degrades (worn out/made obsolete) to provide a unit of service	$\frac{Serv.}{M_{Outflow}}$
Stock maintenance rate	Fraction of material required to maintain stock at a specified level	$\frac{M_{Outflow}}{M_{Stock}}$
Stock evolution range (IQR)	Distance between first and third quartile of the different elements that constitute the stock	$Q3 - Q1$

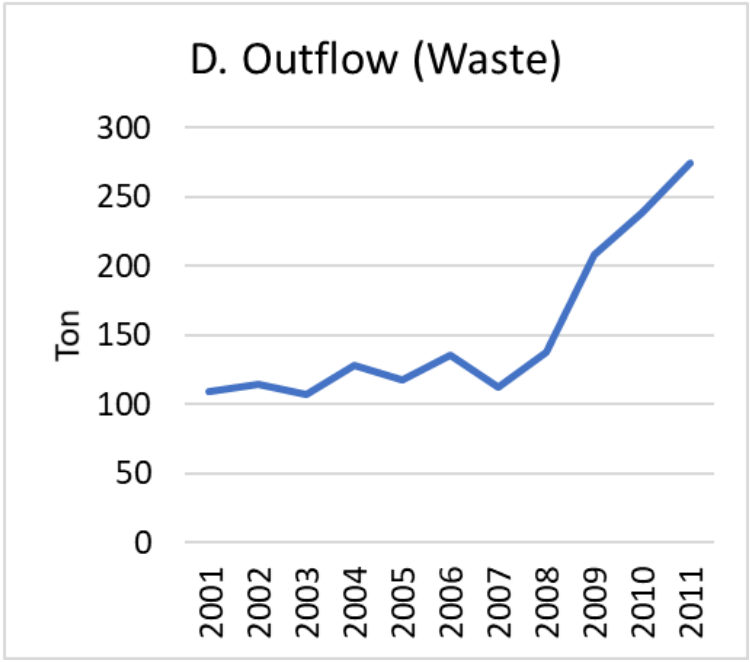
Results

Service, flow and stock variables



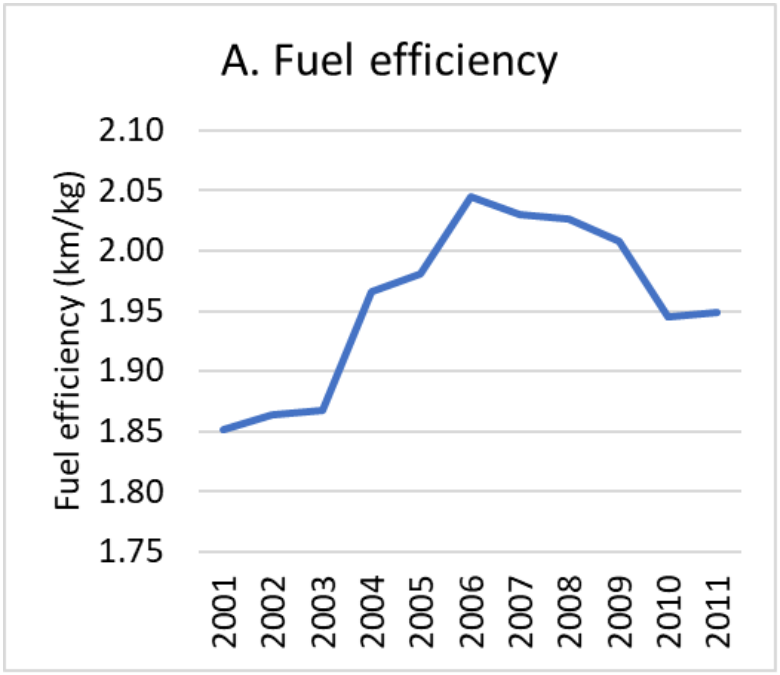


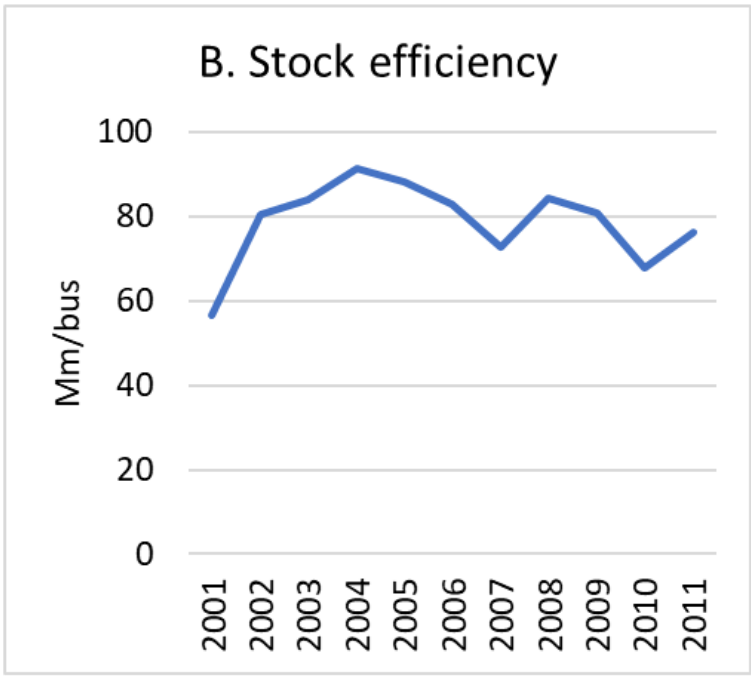


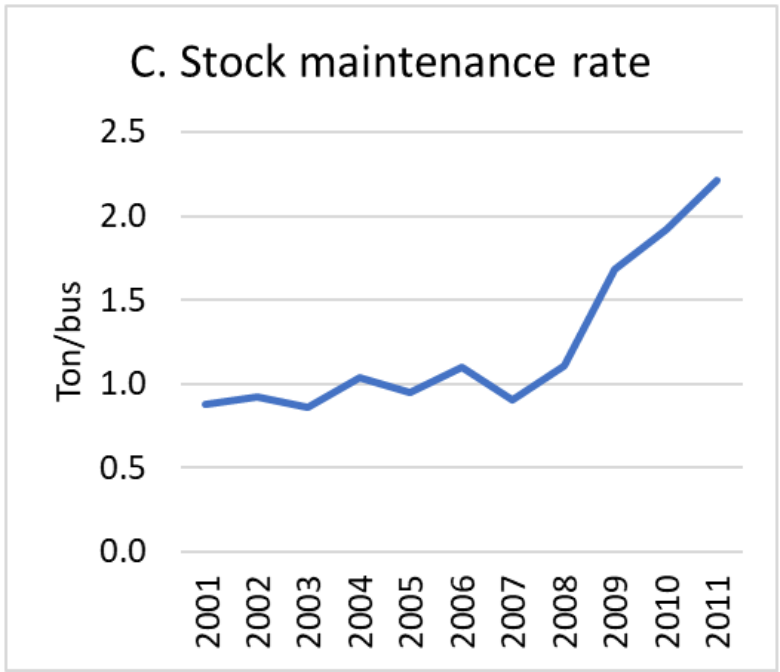


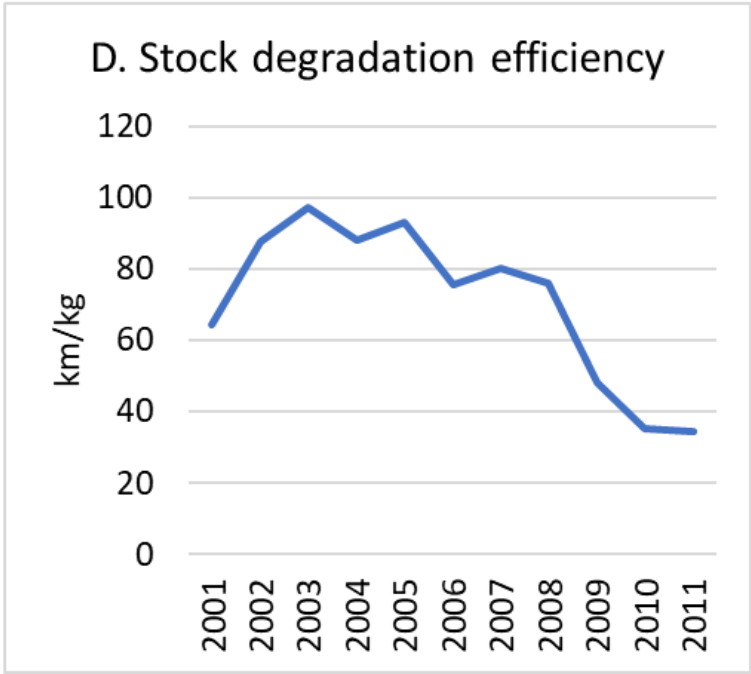
Results

Nexus indicator performance

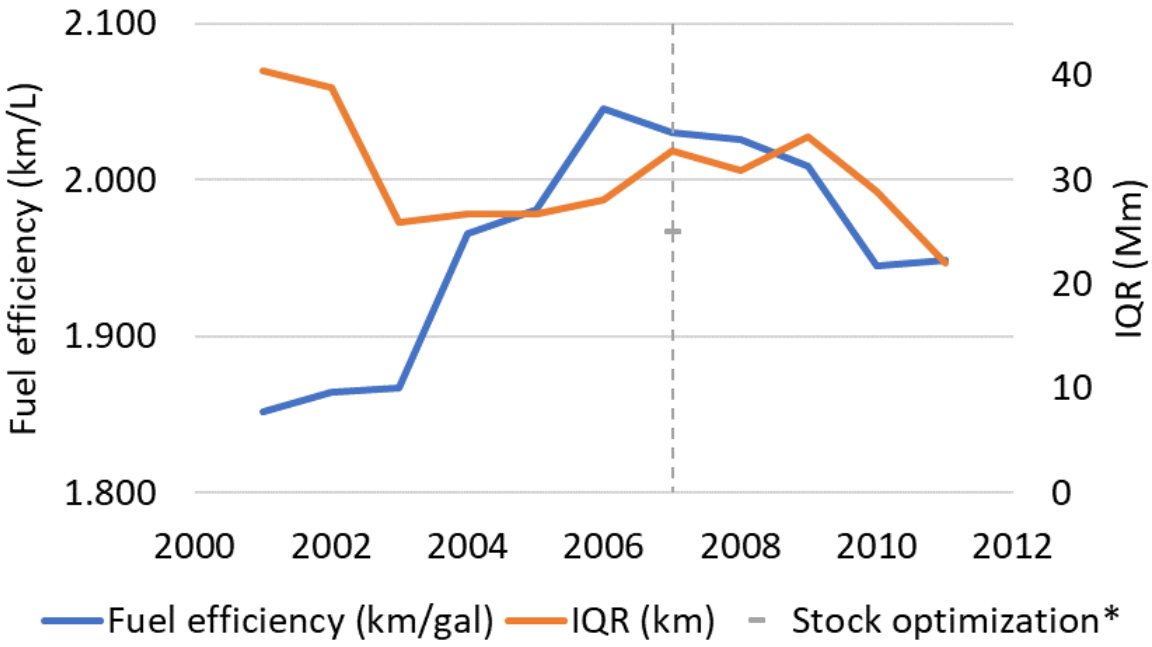




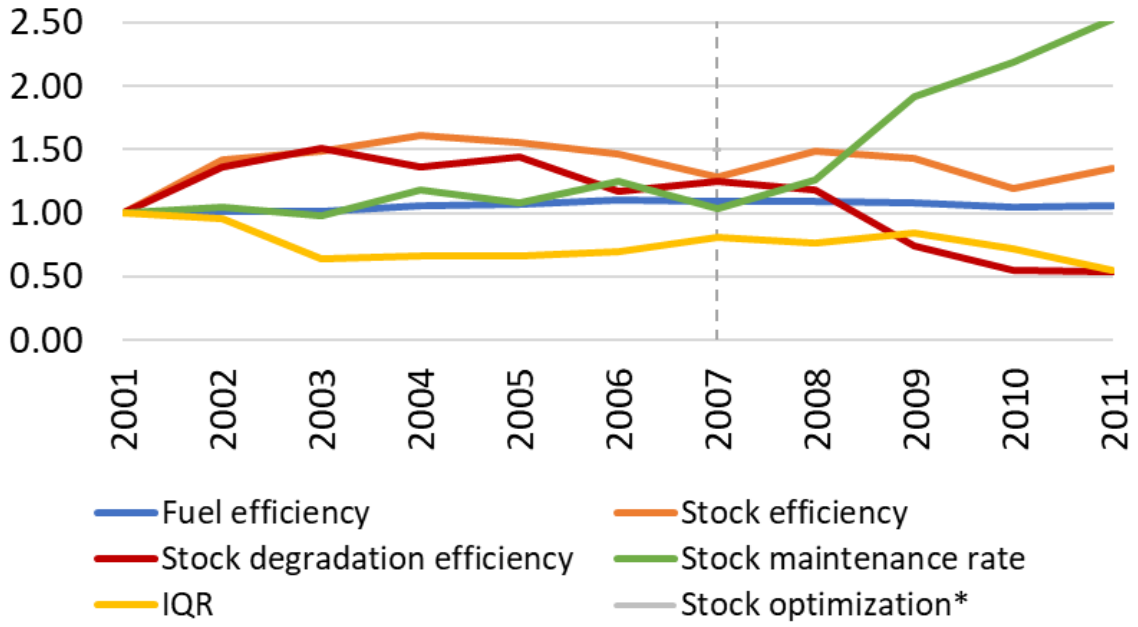




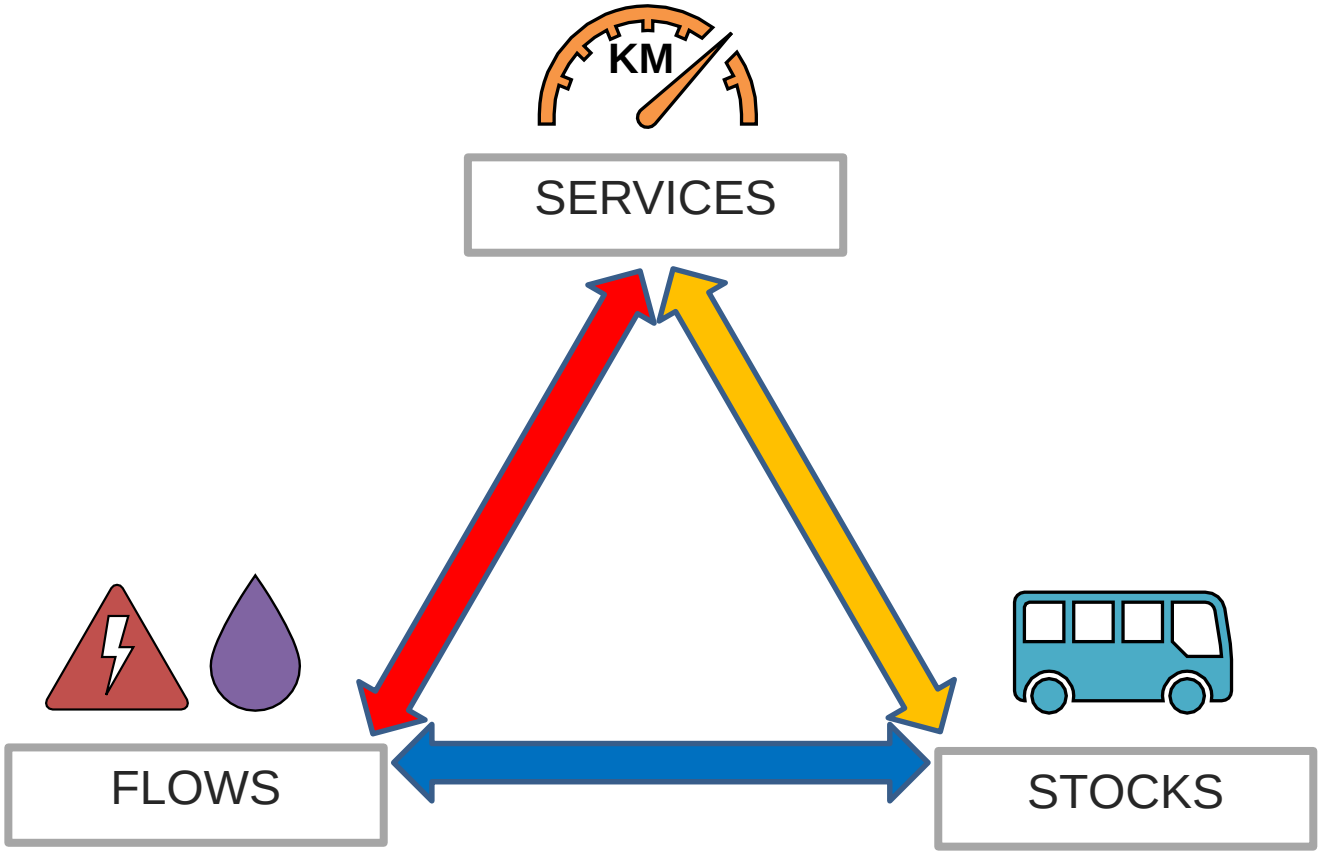
IQR vs Fuel Efficiency



Normalisation



Provides a more comprehensive view of resources that does not overemphasise production aspects at the expense of understanding how resources are used and the extent of which they contribute to services.



Concluding remarks

- How can the nexus concept help us understand the connection between stocks, flows and services?
  - Visualise more clearly the role of materials in society, and the interdependency between the three components of the nexus.
  - Increase awareness regarding the importance of material stocks, how they drive flows (and vice versa) and, by extension, help to determine service quality.
- What do our results mean for the sustainable policy?
  - Better understanding of where, and to what extent, an organisation's physical assets are contributing to strategic goals, such as the optimisation of in-use fleet.
  - Help transport authorities and operators to establish evidence-based targets

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Thank you :)

Any questions?

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